AU/ACSC/0595/97-03

JOINT COMMAND, CONTROL, AND COMMUNICATIONS (C3) UNDER ONE ROOF

A Research Paper

Presented To

The Research Department

Air Command and Staff College

In Partial Fulfillment of the Graduation Requirements of ACSC

by

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March 1997

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (FROM - TO)
01-03-1997	Thesis	xx-xx-1997 to xx-xx-1997

4. TITLE AND SUBTITLE Joint Command, Control, and Communications (C3) Under One Roof Unclassified	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) Mills, Diane M. ;	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME AND ADDRESS Air Command and Staff College Maxwell AFB, AL36112	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS ,	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APUBLIC RELEASE
,

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Can one joint command, control, and communications (C3) platform replace five or more current C3 platforms and achieve the same results or better? Can we save money in the long run by concentrating our efforts on one global C3 system versus the continual research, development, and testing to extend the life of our present air-breathing platforms? These C3 platforms include ground units such as the Air Force ground Modular Control Element (MCE) and airborne units such as the Airborne Warning and Control System (AWACS), Joint Surveillance Targeting and Radar System (JSTARS), and Airborne Battlefield Command, Control, and Communications (ABCCC); as well as our naval counterpart the E-2C Hawkeye. Presently, these units fall under different services, different commands, and speak different techno-babble languages when in fact they all serve the same purpose: relay of real-time information to the battlefield for the decision makers. Can we afford to continue using multiple platforms to achieve the same goal? Can technology not deliver the required information in one package? This research explores two concepts: the feasibility of combining current C3 platforms currently used in the USAF and USN and using commercial space-based satellite technology as the host for joint connectivity.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19. NAME OF RESPONSIBLE PERSON
			Public Release	52	Fenster, Lynn lfenster@dtic.mil
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER International Area Code Area Code Telephone Number 703767-9007 DSN 427-9007

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39.18

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The views expressed in this academic research paper are those of the author and do not reflect the official policy or position of the US government or the Department of Defense.

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Preface

This paper is designed to give the command and control community controversial food for thought regarding the combining of air and ground command and control platforms into a single, fixed unit. For years there has been bantering back and forth with respect to the pro's and con's of combining these platforms; mostly against the combination—not because of lack of technology—but because of emotionalism. People feel threatened when technology can deny them of their livelihood.

As you read through the proposal, the key concept to keep in mind is what this paper is *not* about: it does not address the aspect of defending a battlespace platform from aggression or space debris, nor does it suggest how a satellite or its intended receiver should be designed to accommodate this proposal, but rather the concept of employment of a space-based command, control, and communication sensor.

Gathering the technical and budgetary details of this paper has been the most challenging aspect. The paper would not have reached fruition without the help of my colleagues from the various units: Col Terry F. Green, USAF, Retired. (Boeing Defense and Space Group), MSgt. Steve Schlembach (JSTARS—12 ACCS), Ms Carol Jordan (AWACS—552 ACW), Commander Robert Young (E-2C—VAW 112), MSgt Sherman R. Collins (MCE—605 TS), and Capt. Tony Scelsi (ABCCC—42 ACCS).

Special thanks to several lifetime colleagues in the field of command and control who gave me insight and suggestions where to take the battle manager into the next millennium: Col Jesse Shanks, USAF, Retired. for his nearly 30 years experience in this field, Lt. Col Ron Guziec, USAF, Retired. for making me adhere to the KISS principle in this research, and Dr. Michael Burlein for his technical expertise on many aspects of command and control connectivity and satellite configurations.

Abstract

Can one joint command, control, and communications (C3) platform replace five or more current C3 platforms and achieve the same results or better? Can we save money in the long run by concentrating our efforts on one global C3 system versus the continual research, development, and testing to extend the life of our present air-breathing platforms? These C3 platforms include ground units such as the Air Force ground Modular Control Element (MCE) and airborne units such as the Airborne Warning and Control System (AWACS), Joint Surveillance Targeting and Radar System (JSTARS), and Airborne Battlefield Command, Control, and Communications (ABCCC); as well as our naval counterpart the E-2C Hawkeye. Presently, these units fall under different services, different commands, and speak different techno-babble languages when in fact they all serve the same purpose: relay of real-time information to the battlefield for the decision makers. Can we afford to continue using multiple platforms to achieve the same goal? Can technology not deliver the required information in one package? This research explores two concepts: the feasibility of combining current C3 platforms currently used in the USAF and USN and using commercial space-based satellite technology as the host for joint connectivity.

Chapter 1

The Problem—Multiple C3 Units Performing Like Missions

> *Command and Control (C2)—The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of this mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission*
>
> —Joint Pub 1-02, 23 March 1994

Every day in 1995 a NATO E-3 Airborne Warning and Control System (AWACS) was flying in orbit over the Adriatic Sea near Bosnia-Herzegovina, monitoring the No-Fly Zone as set up in UN Resolution 836.[1] Their mission: detect and transmit pertinent information regarding both friendly and potentially hostile air movement, using their state-of-the-art AN-APY 2 surveillance radar, to the command authorities located in northern Italy. Sharing the airspace in orbits of their own were a EC-130E Airborne Battlefield Command and Control Center (ABCCC) aircraft designed to provide battle management information to air-to-ground friendly aircraft; a USN E-2C Hawkeye radar surveillance aircraft providing command and control information to airborne naval aircraft, as well as the myriad of multinational ships in the Adriatic; and a E-8C Joint Surveillance Targeting and Radar System (JSTARS) aircraft detecting and relaying ground movements to command authorities for tactical decision making. A USAF ground command and control platform referred to as the Modular Control Element (MCE) also provided limited surveillance data to the decision makers in Italy. The C3 platforms shared a commonality: information was gained using a combination of radar and voice transmissions via radio waves. This information was then analyzed and retransmitted to command authorities via digital data links—again using radio waves. The communication equipment of choice to *verbally* relay real-time tactical information was the NATO IVB secure satellite communications (SATCOM) channel. It was not uncommon for over 50 users to simultaneously use the radios, data-links, and SATCOM systems—consequently the systems were quickly saturated during the heat of engagements and contributed to a confusing situation on the C3 platforms as well as the command authorities in Italy.[2]

This scenario replayed itself many times during the now five-year-old civil war in Bosnia-Herzegovina. To further complicate matters, the most accurate air surveillance picture was dependent on all airborne platforms being able to launch from locations across Europe: England, Germany, Italy, Greece, France, and Sicily. The majority of the airborne surveillance missions were generated from a small NATO command post in west-central Germany. Weather was frequently unpredictable six of the twelve months in a year, which kept the current operations branch, command post controllers, and senior leadership working an exhaustible amount of hours beyond their normal duty hours. And then there were the crews. The AWACS unit in NATO was never staffed to endure 24-hour operations for a sustained period. The men and women of this unit were flying up to their 'break-point'[3]—a term referring only to how many hours a crew member can *legally* fly within a 30-day period before the body is considered exhausted. Factor in the maintenance required to maintain a fleet under sustained contingency conditions multiplied by each of the C3 airborne units and the sum total equals a disaster waiting to happen.

The picture painted above gives an idea of the activity and manpower required to support contingency operations as well as how many ground and airborne platforms were either receiving, transmitting, or exchanging critical data to ensure mission success. While the command and control structure within this area of operations was deemed a success, it was largely because of the superb airmanship of the C3 operators providing the information to Italy and using their ingenuity at "work-arounds" when the communication nets became saturated. This scenario begs the question: can the capabilities of these five platforms be consolidated into one fixed site thereby alleviating the appearance of redundant services? Before determining whether these platform missions can be combined, a discussion of the command, control, and communications entity is in order.

The Basics of Command, Control, and Communications

The term "Command, Control, and Communications," or C3, has significantly evolved over the past few years. The current term, referring to the C3 structure, range from "Command and Control" or C2 to the present term "Command, Control, Communications, Computer, Intelligence, Interoperability, Surveillance, and Reconnaissance" or C^4I^2SR. Given today's technology, the latter is appropriate in describing current C3 structure, but for the purposes of this paper, the focus is on the Command, Control, Communications, and Surveillance entities.

The five platforms described in this paper share the commonality of gathering and reporting C3 information to distant users—they differ slightly in the equipment and methods by which that data is transmitted. In essence, all platforms use either (or both) the ultra high frequency (UHF) or high frequency (HF) bandwidths to transmit mission information electronically via digital data links: the SATCOM is used for the transmission of voice information only.

A significant amount of airborne and ground movement information is desirable to make operational or tactical decisions. This information can be gained through data gathered by the C3 platforms. One of the C3 platforms is the AWACS, whose radar can detect airborne objects within 360 miles of its rotodome. It provides commanders the heading, altitude, speed, flight size, and sometimes aircraft type of objects within the AWACS area of responsibility. The Hawkeye is a smaller version of the AWACS and is used by the US Navy in support of fleet operations. Like the AWACS, the Hawkeye detects and transmits the same type of information, but ground commanders usually do not have the data-link equipment needed to translate the information. To work around this problem, the Hawkeye information is transmitted to the AWACS which retransmits the Hawkeye data as well as its own to the decision makers on the ground.

Another airborne radar platform is the JSTARS, but unlike the AWACS and Hawkeye, it is designed to detect ground movement versus airborne movement. The JSTARS radar can detect ground troop and mechanized movement within 120 degrees of its radar aperture.[4] More simply put, the radar detects ground movement at a angle of 60 degrees off either side the JSTARS' nose for a total of 120 degrees. The JSTARS platform carries a uniqueness like no other: it is truly a joint platform. The JSTARS aircrew consists of USAF and USA personnel who data-link C3 information to USA ground service modules (GSMs) on the ground. The control data they transmit is crucial to battlefield commanders in determining forward, rear, or deep battle operations.[5] Unfortunately, the same critical data is not easily transmitted to the command authorities in the overall operation because of hardware differences.

The ABCCC airborne platform does not have radar capability, but a host of radios to perform their job. They rely on the eyes of the surveillance platforms to advise them of threats and location of their air-to-ground and ground assets. In a typical mission, air-to-air assets (normally close air support aircraft) will check in on the ABCCC pre-described frequency, verify their task, perform the task, report back to ABCCC with battle damage assessments (BDA), then return to home base. BDA reports are usually transmitted via secure SATCOM—this command and control information is required by the decision-makers to plan future missions.

Finally, the last C3 platform is the MCE. The MCE is a self-contained, rapidly deployable C3 unit that replaced the aging and not-so-mobile TSQ-91 “heavy” ground tactical system. Its capabilities are like that of the AWACS—the radar can detect heading, altitude, speed, and flight size, but is limited to line-of-sight, high terrain, and adverse weather. The command and control information gained by the MCE is transmitted via several different types of data-link, as well as SATCOM capabilities for verbal coordination.

When combining the platform capabilities, commanders receive superb command, control, and surveillance information via one of the several connectivity nodes. Simple as this sounds, the coordination required to mesh all this information into usable data is extremely cost-inefficient. The best way to support this statement is to take a look at the strengths and weaknesses of each platform.

Platform Description, Strengths, and Weaknesses

The AWACS has several variants—The E-3A, E-3C, E-3D, E-3F, and E-3J, owned and operated by NATO, USAF, Royal Saudi Air Force, United Kingdom's Royal Air Force, French Air Force, and Japanese Air Force. For the purposes of this discussion, the focus will remain with the USAF fleet of 32 E-3C aircraft (figure 1) based at Tinker AFB, OK.

Source: 552 ACW Home Page, *Welcome to the 552d Air Control Wing!"*, maintained by the 752d Computer Systems Squadron, (Tinker AFB, 12 March 1997), n.p.

Figure 1. E-3C AWACS

The E-3 AWACS houses the AN/APY 2 radar which has the ability to look down and recognize low-flying strike aircraft that can evade ground-based air defense radar. It contains a radar subsystem that permits surveillance from the Earth's surface up into the stratosphere, over land or water. The radar has a range of more than 200 miles (320 kilometers) for low-flying targets and farther for aerospace vehicles flying at medium to high altitudes. The radar combined with an identification friend or foe subsystem can look down to detect, identify, and track enemy and friendly low-flying aircraft by eliminating ground clutter returns that confuse other radar systems.[6] It can operate in various radar modes including pulse doppler (short to medium range), beyond the horizon (long range), and various maritime modes to detect water surface contacts. This includes position and tracking information on enemy aircraft and ships, and location and status of friendly aircraft and naval vessels. The information can be sent to major command and control centers in rear areas or aboard ships. In time of crisis, the data can be forwarded to the National Command Authorities in the United States.[7]

The AWACS communications suite consists of an assortment of 19 radios, two data links referred to as intermediate joint message system (IJMS) and tactical data link (TADIL-A) which both use the UHF and HF bandwidths, and is acquiring joint tactical identification system (JTIDS)[8] which uses only the UHF bandwidth. Recent modernization includes a supplemental passive radar detection system to help identify aircraft according to type as well as additional consoles allowing more crew members to perform lengthy missions. The aircrew, consisting of 17 to 30 members, analyze the information detected by the radar sensors, track and identify each contact within their area of responsibility, then transmit the information via one or all of the data link means to one or any given number of link-compatible recipients. The AWACS strengths are many: the radar can detect objects exceeding 200 miles; the numerous data link systems range not only provide redundancy, but offer varied degrees of electronic jam resistant capabilities; information is relayed in real-time for the decision-makers; and highly trained crews. The weaknesses directly offset the strengths: radar detection is optimum when the correct orbit is used and this is not always possible. For data link connectivity, the TADIL-A can be electronically jammed and is extremely susceptible to anomalous weather propagation.

The IJMS data links aren't compatible with most USN vessels nor several ground units. Since the IJMS and JTIDS links are UHF-capable only, they limited to line-of-sight operations. In regard to experience level and training of the aircrews, the downsizing of the forces has rendered our aircrews very young and inexperienced. An added weakness within the AWACS structure is the continual high cost of maintaining an aging aircraft. Some of the aircraft are over 20 years old—original design life was 15 years (26,000 hours for airframe, 30,000 hours for struts, pedestal and antenna).[9] Research and development is in full swing to modernize and/or replace the airframes, but the cost of replacing the fleet is frightening given today's economics.

The oldest of the airborne early warning platforms is the E-2C Hawkeye (figure 2) which is operated by the USN and used primarily as an airborne early warning platform providing airborne surveillance and interceptor control at the outermost region of a naval task force's layered defense zone.[10] It operates either from land or aircraft carrier and provides strike, interceptor, air traffic control, surveillance coordination, search and rescue control, and automatic tactical data and comm. relays.[11] The Hawkeye provides all-weather airborne early warning as well as command and control functions for the carrier battle group. An integral component of the carrier air wing, the E-2C uses computerized sensors to provide early warning, threat analyses, and control of counteraction against air and surface targets.[12]

Source: Navy Fact File, *E-2C Hawkeye*, Naval Air Systems Command Public Affairs Office, (Washington DC, 12 March 1997), n.p.

Figure 2. E-2C "Hawkeye"

The workhorse of the Hawkeye is the AN/APS-138 surveillance radar which has similar capabilities to the AWACS in its radar range, passive radar system, radio, and data-link suites. Unlike the AWACS, it does not possess IJMS and therefore cannot link to ground units whose only link is the IJMS[13]; however, recent modernization includes full JTIDS capabilities. Within the airframe, the crew of three mission controllers track, identify, and relay information to airborne fighter aircraft, other link-compatible airborne units, and fleet leadership within the carrier group.[14] Its strengths are much like that of the AWACS in its detection range and varied methods of connectivity as well as highly trained aircrews. The crew provides real-time information to the battle group to assist in rapid decision making. One of the weaknesses lie in its sustainability. The Hawkeye has a maximum airborne duration time of 5 hours (compared to the AWACS with 16 hours) before it must land on the carrier to refuel.[15] Another weakness, and the most significant in a joint arena, is the lack of data-link compatibility with any but other USN vessels/aircraft or other C3 platforms that still maintain the antiquated TADIL-A data link system or have not yet modernized to include full JTIDS systems.

The newest C3 airborne development is the E-8 JSTARS (figure 3). It is a joint USAF/USA development to provide a stand-off airborne radar and command and control system to detect and track first- and second-echelon armored targets and direct tactical weapons against them.[16] The system combines the Air Force's Pave Mover Synthetic Aperture Radar (SAR) program and the Army's battlefield data systems projects in the Assault Breaker program.[17] The E-8 carries the 24-foot synthetic aperture radar antenna in a belly-mounted pod—it looks much like a canoe on the underside. The side-looking, multimode, time-sharing radar system provides a 120-degree area surveillance together with "spotlighting" facilities and moving target indicator out to a range of 120 miles.[18]

Source: E-8C Joint Stars, *The Gulf War*, Frontline (12 March 1997), n.p.

Figure 3. E-8C JSTARS

While the E-8 aircrew of 22 flies at an altitude of 29,000-33,000 feet, mission specialists can transmit precise locations of critical non-moving targets such as fighting vehicles, helicopters, low-speed aircraft, missile launchers, rotating antennas, ships/barges, tanks, trucks/convoys[19] to its GSM (figure 4). The Army uses raw data from the E-8, processed into the GSMs, then disseminates valid data to tactical operations centers, line support elements, and artillery commanders at division and corps levels.[20] The communications aboard the E-8 consists of 17 UHF/VHF/HF radios and one SATCOM radio suite as well as TADIL-J, IJMS, Surveillance Control Data Link (SCDL), Constant Source, and Deployable Ground Support System (DGSS) data links (figure 5).

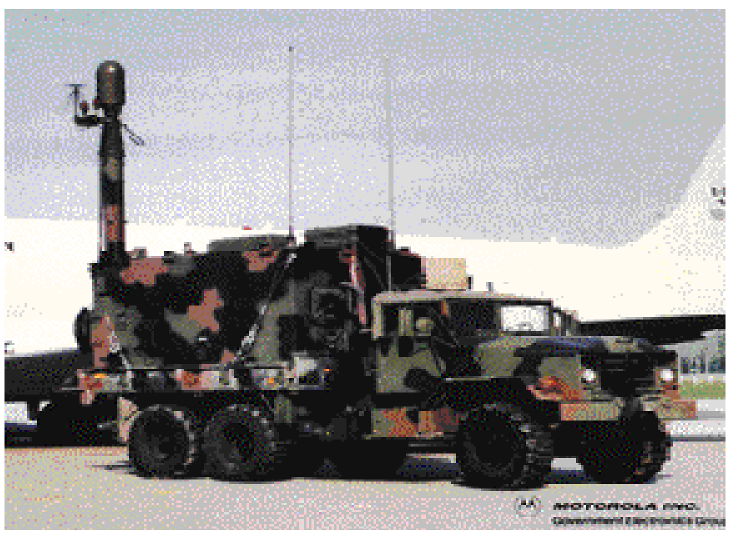
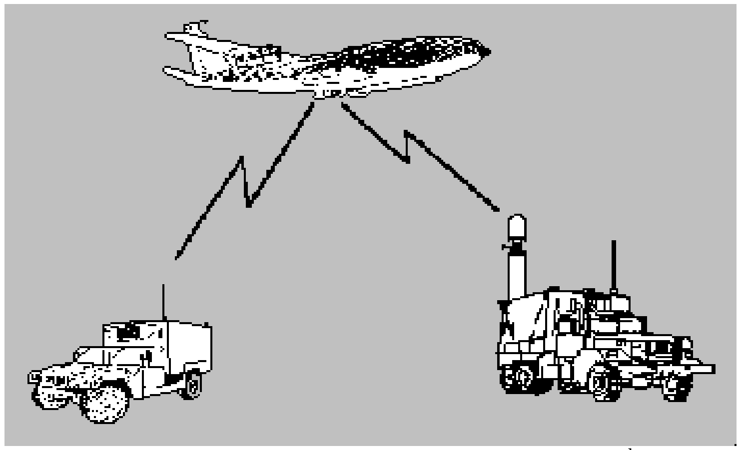


Figure 4. Ground Service Module



Source: Peter Rackham, *Jane's C3I Systems,* 5th Edition (Alexandria, VA: The Thompson Publishing Company), 1993-94), 253.

Figure 5. JSTARS Connectivity Sheme

The strengths in the joint area clearly rest in connectivity between the USAF and USA as well as communicate with most other C3 platforms. However, it falls woefully short in its capabilities to transmit data to USN warships that are TADIL-A capable only. The logistics train of the JSTARS can be considered a weakness. Due to the large aircrew size and number of maintenance teams required to maintain the aircraft, the JSTARS is only deployable to a select few airports.

The EC-130E is a modified C-130 "Hercules" aircraft designed to carry the USC-48 Airborne Battlefield Command and Control Center Capsules (ABCCC III). These one-of-a kind aircraft include the addition of external antennae to accommodate the vast number of radios in the capsule, heat exchanger pods for additional air conditioning, an aerial refueling system, and special mounted rails for uploading and downloading the USC-48 capsule.[21] While functioning as a direct extension of ground-based command and control authorities, the primary mission is providing flexibility in the overall control of tactical air resources. In addition, to maintain positive control of air operations, ABCCC can provide communications to higher headquarters, including national command authorities, in both peace and wartime environments.

The USC-48 ABCCC III capsule, which fits into the aircraft cargo compartment, measures 40 feet long, and weighs approximately 20,000 pounds. The ABCCC system is a high-tech automated airborne command and control facility featuring computer-generated color displays, digitally controlled communications, and rapid data retrieval.[22] The platform's 23 fully encrypted radios, encrypted teletype, and 15 automatic fully computerized consoles, allow the battlestaff to quickly analyze current combat situations and direct offensive air support towards fast-developing targets.[23] The primary data link is a scaled-down version of full JTIDS; however, the ABCCC unit expects to have full transmit and receive JTIDS capabilities by the end of fiscal year 1997 which will allow real-time accountability of airborne tracks to capsule displays through data links.

The superb communication capabilities of the ABCCC are obvious, due to the large number of encrypted radios available to the crewmembers. It is not unrealistic for the ABCCC to maintain connectivity between the command authority on the ground, several air-to-ground aircraft mission packages, ground battlefield units, and supporting C3 elements both in the air and ground. Due to the small size and light weight of the ABCCC III capsule and aircraft, this C3 element is highly mobile and can land on short, semi-improved airstrips, allowing it to forward deploy to airfields that cannot handle the larger C3 systems such as the AWACS or JSTARS. Added to the list of qualities is its air-refueling capabilities—the aircraft can stay airborne upward to 18 hours—a true force multiplier. The biggest limitation to the ABCCC fleet is it has exceeded its design life and replacements are not projected until fiscal year 1998 at the earliest.[24] The seven EC-130E aircraft are of 1962 vintage and have flown over 31,000 hours. Original specifications for this aircraft design conclude the aircraft are over their "original shelf life," but due to the nature of the EC-130E flight characteristics (usually flying in circular orbits), the aircraft should have a bit more "shelf life" than the average airlifter.[25] Although not a limitation, a big drawback to the ABCCC III is the orbit location required to perform the mission. In order for the ABCCC crewmembers to maintain radio connectivity with ground units (which are often buried in hilly or mountainous terrain), the aircraft must orbit *within* enemy territory and frequently *within* enemy surface-to-air missile ranges. For this reason alone, it would seem appropriate to pursue space-based platforms to perform the ABCCC connectivity function and remove our men and women from harm's way.

Along the same lines, MCE units frequently deploy to the forward edge of battle areas. Key to the MCE is its flexibility—the unit can take just a fraction of its people and equipment to a deployed location, or can mobilize the entire squadron for large-scale operations. A full-scale MCE unit is comprised of assorted operational support modules, TPS-75 radar, a myriad of modules containing radio and data link connectivity equipment, as well as support equipment to include field kitchens, sleeping and recreational quarters, generators, trucks, trailers, and self-sustainment units. Once deployed and operational, the activity is centered around the operations modules. The radar detects airborne objects within 250 miles of its radar and sends a host of information to the computer within the MCE. The computer digitally translates the data for the console operator to analyze and apply to the tactical situation. The operator simultaneously transmits the information to the aircraft under her control as well as to other units connected to the MCE via data link.

The MCE's biggest contribution to C3 is its mobility and sustainability. A large MCE unit can pack, deploy, and become operational within 24 hours from execution orders (this does not include the time required to transport to a port of debarkation, airlift, or transportation time to the site.) Once deployed, the unit can independently sustain itself for a finite number of days (depending on the location of the mission) before fuel, food, and water resupply is required. The men and women of these units are highly trained to deploy, operate, and sustain operations under nearly every type of expected climate conditions.

The MCE operational capabilities are not unlike the AWACS. The biggest difference lies in detection capabilities: the MCE sits on the ground and is subject to line-of-sight detection. In other words, if there are mountains or even large buildings between the radar antenna and a low-flying aircraft, that aircraft may not be detected. The biggest limiting factor to the MCE is its enormous logistics train. To deploy a full-scale MCE, it takes an impressive number of operations modules, five-ton trucks, 21/2 ton trucks, communication modules, supporting vehicles, supporting shelters, and of course the men and women to operate and maintain the system.

The five C3 platforms described above do not exist without a hefty price tag. The next chapter will look into the costs of maintaining aircrews, ground crews, aircraft, and equipment using the current cost index.

Notes

[1] Information contained in this paragraph is derived through author's personal experience entailing more than 14 years in command and control and nearly 4,000 hours in the AWACS aircraft.

[2] Ibid.

Notes

[3] "Break-point" is a term used by the author. No such official term exists; however, actual rules governing aircrew flight requirements are presented in E-3A Component Manual (E-3ACM) 80-101-10, *Flying Operations Manual*, 16 Mar 95, I-3-5.

[4] Peter Rackham, *Jane's C3I Systems,* 5th Edition (Alexandria, VA: The Thompson Publishing Company), 1993-94), 253.

[5] Ibid.

[6] USAF Fact Sheet 96-13, *E-3 Sentry (AWACS)*, Air Combat Command Public Affairs Office, (Langley AFB, March 1996), n.p.

[7] Ibid.

[8] MSgt Steven Schlembach, former member of 552 ACW, interviewed by author, 17 November 1995.

[9] Mr. Terry F. Green, The Boeing Defense and Space Group, interviewed by author, 13 November 1996.

[10] Peter Rackham, *Jane's C3I Systems,* 5th Edition (Alexandria, VA: The Thompson Publishing Company), 1993-94), 251.

[11] Ibid.

[12] Navy Fact File, *E-2C Hawkeye*, Naval Air Systems Command Public Affairs Office, (Washington DC, 12 March 1997), n.p.

[13] Commander Robert A. Young, Commanding Officer, CARAEWRON ONE ONE TWO, USS Nimitz, interviewed by author, 18 November 1996.

[14] Navy Fact File, *E-2C Hawkeye*, Naval Air Systems Command Public Affairs Office, (Washington DC, 12 March 1997), n.p.

[15] Commander Robert A. Young, Commanding Officer, CARAEWRON ONE ONE TWO, USS Nimitz, interviewed by author, 18 November 1996.

[16] Peter Rackham, *Jane's C3I Systems,* 5th Edition (Alexandria, VA: The Thompson Publishing Company), 1993-94), 253.

[17] Ibid.

[18] Ibid.

[19] Ibid.

[20] Peter Rackham, *Jane's C3I Systems,* 5th Edition (Alexandria, VA: The Thompson Publishing Company), 1993-94), 253.

[21] 355th Wing, *The EC-130E "Hercules"*, (Davis-Monthan AFB, September 1994), n.p.

[22] Ibid.

[23] Ibid.

[24] Capt Tony Scelsi, 42 ACCS, interview by author, 24 February 1997.

[25] Ibid.

Chapter 2

The Cost Of Present Operations

> *While we recognize the need for interoperable systems and infrastructure, we must also recognize today's new emphasis on a balanced federal budget. Diminishing budgets will significantly affect the way we acquire new systems, or change existing ones. We can no longer afford stovepipes.*
>
> —The Honorable Emmett Paige, Jr., 13 May 1996

The costs of maintaining the present C3 structure in terms of equipment and manpower are staggering. A probe into the annual operating costs of each C3 platform indicates the taxpayer may well be footing an annual bill of just over $1 billion dollars in what may be determined as redundant capabilities. To validate this cost figure, the follow paragraphs examine recent annual operating budgets of each C3 platform.

E-3 AWACS Fleet

Tinker AFB, Oklahoma is the home of the largest AWACS fleet in the world. Its 32 functional aircraft require the services of the 552 LG which consists of the Maintenance Quality Assurance Division, the Logistics Support Squadron and the Maintenance Squadron. The Quality Assurance Division determines aircraft and equipment condition, ways to increase their reliability and maintainability, and determines personnel proficiency.[1] The Logistics Support Squadron directs all civil engineering, personnel, information management, logistical plans, supply, security, environmental programs, and mobility operations for the 552 ACW.[2] Additionally, it performs maintenance support and conducts training for all wing logistics/maintenance personnel. The Maintenance Squadron provides extensive local equipment support for worldwide employment of the AWACS. Also, for those aircraft, it performs phase inspections, employing technicians who specialize in all aspects of airframe maintenance and refurbishment, mission and flight avionics, mission simulators, aircraft accessory and propulsion systems, and maintains a vast armada of over 650 units of powered and nonpowered aerospace ground equipment.[3]

The estimated annual logistics operating budget for 1996 was slightly over $9 million.[4] This figure represents the logistics group that employs an average of 1240 military personnel ranging in rank from airman basic (E-1) to colonel (O-6) and includes quarters, subsistence, and planned temporary duty supplement monies. Aircraft maintenance costs are also included in this figure.[5]

The 552d Operations Group consists of the three operational flying squadrons as well as an operations support squadron, a maintenance squadron, and a training squadron. The 963rd, 964th and 965th Airborne Air Control Squadrons provide worldwide response with the E-3 aircraft. The support structure and aircrew member strength within the operational squadrons average a total of 1,951 members.[6] The 952d Aircraft Generation Squadron provides, maintains, and sustains combat mission ready aircraft for the wing worldwide, anytime, anywhere. Its manning strength is approximately 330 personnel.[7] The Operations Support Squadron manages virtually all E-3 operations. It develops and implements combat training programs and manages contracts to train over 1,600 flight and mission crew members. The squadron provides maintenance, intelligence, and contingency planning elements supporting worldwide operations, counterdrug surveillance, and strategic defense.[8] The 552d Operations Group annual budget for 1996 was estimated at $65.4 million.[9]The total annual AWACS operating price tag is estimated to be $74 million.

E-8 JSTARS Fleet

Robins AFB, Georgia is called home base for the JSTARS and the 93rd Air Control Wing. One unit within the wing is the 93rd Operations Group which consists of a flying squadron, computer squadron, operations support squadron and a training squadron. Presently, the unit operates 2 aircraft[10] and anticipate an additional 17 upon completion of production.[11]

The 93rd Computer Systems Squadron provides 24-hour computer support, computer security, and ground communications at home base and to deployed units. The squadron also provides combat software for Joint STARS platforms. In addition, the unit participates in joint interoperability testing and operates integrated testing facilities for Joint STARS missions.[12]

The 93rd Operations Support Squadron is responsible for rapid response planning, scheduling, readiness, intelligence, weapons and tactics of Joint STARS. The squadron also operates and supports E-8 forces worldwide, ensuring combat capability for all operations.[13]

The 93rd Training Squadron provides the wing with mission-ready air crews to employ the E-8. In cooperation with Northrop Grumman Corp., the 93rd Air Control Wing facilitates initial and mission qualification training as well as continuation training.[14]

Maintaining the JSTARS aircraft is the 93rd Logistics Group, comprised of a logistics support squadron and a maintenance squadron. The 93rd Logistics Support Squadron maximizes the 93rd Air Control Wing's combat capability by providing logistics support. The 93rd Maintenance Squadron provides extensive local equipment maintenance for worldwide employment of the JSTARS aircraft. The unit performs phase inspections and employs technicians specializing in all aspects of airframe maintenance, refurbishment, avionics, mission simulators, and aircraft accessories. In addition, the squadron maintains a vast armada of over 450 units of powered and non-powered aerospace ground equipment valued at over $16 million.[15]

The USA ground counterpart to the JSTARS is the 513th Military Intelligence Brigade. Under the direction of the 93rd Air Control Wing commander, the Army provides officer and enlisted personnel to serve as Joint STARS air crew members and to man key wing staff positions.[16]

To summarize, the JSTARS unit employs six squadrons—flying, computer operations support, training, logistics support, and maintenance squadron, as well as a USA brigade. When the unit has achieved full strength, it will be authorized approximately 180 operators and 170 maintenance personnel. Because the JSTARS is in its infancy, Air Combat Command (the JSTARS major command) could not accurately forecast the annual operating budget for the 93rd Air Control Wing once fully operational. However, given the unit size of 19 aircraft and over 350 personnel, this equates to approximately sixty percent the size of the AWACS unit. Sixty percent of the AWACS budget of $74 million is $45 million and can be reasonably used as a baseline for the JSTARS annual operating budget. Add to this figure the cost of acquiring the additional 17 aircraft at $850 million[17]a copy, or nearly $16 billion dollars. Amortizing the costs of 19 aircraft ($16 billion dollars), existing equipment costs ($16 million dollars), military construction costs

($120 million dollars[18]) over a 20-year period, and the extrapolated annual operating budget of the operations and logistics group ($45 million dollars), the JSTARS unit is costing the American people a very conservative estimate of $875 million dollars a year.

EC-130E ABCCC fleet

The C-130 is one of the oldest aircraft left in the active duty Air Force inventory. Built in the 1950s, it has served well beyond its designed life period thanks not only to the superior design of the aircraft, but the men and women who maintain the fleet. Based at Davis-Monthan AFB, Arizona, the seven EC-130E ABCCC aircraft belong to the 355th Wing composed of an Operations Group as well as a Component Repair Squadron, Contracting Squadron, Equipment Maintenance Squadron, Logistics Support Squadron, Supply Squadron and Transportation Squadron.[19] The 42 ACCS is authorized approximately 366 personnel of which 235 belong to the operations group, and the remaining personnel belonging to maintenance areas.[20] The 1996 operating budget for this unit divided into the following categories: $480,000 as a baseline which included operational expenses, equipment, computers, and furniture; $700,000 dedicated to the flying hours program which included all expenses to fly the aircraft (fuels, oil, maintenance, some equipment issue and parts), and approximately $1 million for large-scale parts and its surplus. The unit estimated that, in 1996, $2.2 million was required to train, equip, and maintain this command and control platform.[21] To finalize the tab, Lockheed Martin will deliver the first of seven EC-130J aircraft in October 1997 to the tune of $70.5 million per unit, or a total cost of $494 million for the fleet.[22] Amortizing this fleet over a 20-year period and adding the present operating budget, the annual costs to operate the ABCCC unit can be estimated at $25.5 million.

E-2C Hawkeye fleet

The extended eyes and ears of the ship at sea belong exclusively to the E-2C Hawkeye and her crew. There are 10 operational squadrons divided between the east and west coasts of the United States—five operational squadrons at San Diego, California and five operational squadrons (plus a training squadron) at Norfolk, Virginia.[23] Each operational squadron possesses four E-2C aircraft and is authorized 25 aircrew members and three maintenance officers.[24] In addition, each squadron can have as many as 134 enlisted members (prior to cruise) to maintain the aircraft—approximately 14 of the 134 enlisted members are senior non-commissioned officers.[25] Interestingly, the cost of maintaining an E-2C unit, in terms of both personnel and maintenance operating costs, are not significantly different when operating from the carrier versus dry land at San Diego or Norfolk. However, costs will vary when at sea if the aircraft are operating from a conventional or nuclear-based platform.[26]

The low-end operating costs for an E-2C unit are estimated as follows: annual maintenance budget, approximately $4.5 million; fuel and spare parts for the aircraft estimates $711,400; and operating fuel costs estimates around $51,000.[27] These annual costs per unit run a little over $5.2 million. Multiply this figure by 10 E-2C squadrons and one can estimate a ball park annual operating budget figure for the E-2C fleet as $52 million.

A "Heavy" Modular Control Element (MCE) Unit

There are only two large, or "heavy", operational ground tactical C3 units left in the United States: the 728 ACS based at Eglin AFB, Florida and the 729 ACS at Hill AFB, Utah. The organizational structure within a MCE units consists of the standard command staff with operations, maintenance, and support elements. The unit is authorized a personnel strength of over 150 which include its operators, maintenance personnel, and support staff. Annual operating costs for a heavy MCE unit round out at approximately $2 million.[28] This is the estimated cost for one heavy MCE unit—the USAF maintains two heavy MCE units plus a host of smaller "light" MCE units based within the United States and overseas.

May I have the Check, Please?

It is time to add the tangible estimated costs together. The AWACS annual operating budget estimates at $74 million dollars; the JSTARS at $874.5 million dollars (costs of future airframes and facilities construction included, since they have been funded); the ABCCC at $25.5 million, the E-2C fleet at $52 million, and *one* heavy MCE unit at $2 million. These are conservative cost figures as they do not reflect temporary duty costs incurred by military requirements, civilian hires while the units are in garrison, or the second heavy MCE and smaller light MCE units. Combined, the taxpayers are paying approximately *$1.02 billion dollars* annually to operate and maintain these five C3 systems. As of this writing, the Quadrennial Defense Review has yet to happen but indicators show the Defense Department will take another hit in its budget. What if the capabilities of the five C3 platforms could be combined onto one space-based, civilian-led, satellite constellation to the tune of $9 billion lump sum cost (a cost that represents fifty percent of the acquisition cost for the entire JSTARS fleet)? The remainder of this paper addresses this very probability.

Notes

[1] 552 Logistics Group, *Organization* (Tinker AFB, 12 March 1997), n.p.
[2] Ibid.
[3] Ibid.
[4] Ms Carol Jordan, 552 ACW, interviewed by author, 17 November 1995.
[5] Ibid.
[6] 552 Operations Group, *Organization* (Tinker AFB, 12 March 1997), n.p.
[7] Ms Carol Jordan, 552 ACW, interviewed by author, 17 November 1995.
[8] 552 Operations Group, *Organization* (Tinker AFB, 12 March 1997), n.p.
[9] Ms Carol Jordan, 552 ACW, interviewed by author, 17 November 1995.
[10] MSgt Steven Schlembach, 12 ACCS, interviewed by author, 17 November 1995.
[11] FIRST Website, 12 March 1997, n.p.
[12] JSTARS Home Page, (Robins AFB, 16 December 1996), n.p.
[13] Ibid.
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[15] Ibid.
[16] Ibid.
[17] JSTARS Home Page, (Robins AFB, 16 December 1996), n.p.
[18] Ibid.
[19] 355 Logistics Group Web Site, (Davis-Monthan AFB, 14 December 1996), n.p.
[20] 42d Airborne Command and Control Squadron (ACC), "42 ACCS Capability," (Davis-Monthan AFB, 18 March 1996), n.p.
[21] Captain Tony Scelsi, 42 ACCS, interviewed by author, 17 November 1996.
[22] Air Force Magazine, *Snapshots of Force Modernization*, John A. Tirpak, Senior Editor, Vol. 80, No. 2, (Air Force Association, February 1997), 24.
[23] Commander Robert A. Young, Commander, CARAEWRON ONE TWO, USS Nimitz, interviewed by author, 18 November 1996.
[24] Ibid.
[25] Ibid.
[26] Ibid.
[27] Ibid.
[28]Member of 728 ACS, Eglin AFB, interviewed by author, 24 March 1997.

Chapter 3

Trying “Joint Battlespace” On For Size

In recent years the C4I community, like the larger commercial community, has experienced a series of changes that force a reexamination of basic ways we conduct our business. Diminishing resources along with downsizing have required us to look to technology for innovative solutions. Our military forces now operate in an environment characterized by a more rapid pace of change than at any time in history—a pace accelerated by political forces, by economics, and by technology.

—The Honorable Emmett Paige, Jr., 4 June 1996

Gone are the days that we can afford to continue “stovepiping” our limited resources. With the exception of the JSTARS platform, each C3 unit is dedicated to its own service, serving its own mission, with limited interchange of ideas and even more limited means of interoperability. Integrating the USAF concept of surveillance and USA concept of maneuver warfare, we’re stepping in the right direction toward battlespace dominance, but it’s only a small step. Economically, we must take a giant step.

The Battlespace Concept

It’s the year 2020. Deep within a mountain in central United States is the US Joint Warfare Service (USJWS) consisting of airmen, soldiers, sailors, and marines observing, calculating, interpreting, and relaying space-borne data to the battlefield commander thousands of miles away. The sensors detect 14 corps-level enemy units approaching a previously defined line of demarcation of country “X” and carrying an array of laser-guided munitions, hand-held phasers, and 42 long-range missile systems with a payload of unknown substances. In addition, sensors detect forward basing of enemy aircraft to the outermost edge of its boundaries. Simultaneously the enemy navy has launched a small, but significantly armed, surface and subsurface fleet from its home port and are rapidly approaching the friendly coastline as well is our own navy. The US Department of Defense maintains a Corps-level joint unit in country X that works in concert with the host country—they have requested increased intelligence satellite feeds as well as rapid airlift to increase their defense posture. The USJWS members activate another 75 secure feeds from a commercially-owned satellite constellation in a low-earth orbit which provide the battlefield commanders with live imagery of airborne enemy aircraft, surface and subsurface contacts, and ground movements. The USJWS members work as one team to filter noise information to prevent the battlefield commanders from information overload.

Back to the present day. With the exception of the satellite constellation feeds, the US services perform these tasks today using the AWACS, JSTARS, Hawkeye, ABCCC, and MCE. We deploy these five costly, highly-mobile platforms and their support structure to the field for the purpose of providing the battlefield commanders with real-time information. What if technology could integrate the required detection and communication sensors onto future commercial satellite constellations? Could we save money in terms of aircraft, crews, or maintenance? Even more significantly, look at what we can gain in terms of lives saved.

Technical Aspects

A myriad of satellite constellations exist in space overhead, owned by different countries and serving different purposes. There are satellites for communication, navigation, telephones, cellular telephones, internet activity, military applications, and so forth. Satellite systems are of two general types: geostationary-earth-orbit (GEO) and non-geostationary, primarily low-earth-orbit (LEO). Geostationary satellite systems orbit at an altitude of 36,000 kilometers (km) above the Equator—the only orbit that allows the satellite to maintain a fixed position in relation to Earth.[1] Since the nature of military application is mobile, military-use satellite systems need to be continually accessible regardless of the user's location—in a LEO. The system must accommodate a full range of military encrypted satellite communications (SATCOM), digital data link, and radar/identification frequency bands.

The five C3 platforms described in this paper all currently possess voice SATCOM capabilities. Technology has already provided the conduit to combine the connectivity requirements for the C3 platforms. What technology needs to develop and acquire is the other half of the C3 equation—detection sensors via satellites. Given a large satellite constellation, maintained in a circular low-earth orbit of 60 to 300 miles, consisting of radar and IFF sensors capabilities equivalent to the AWACS, JSTARS, MCE and Hawkeye as well as a complete communications suite required by the ABCCC, the Defense Department could eliminate the need to equip, maintain, train, and support the present C3 units operating today at the cost of $1.02 billion dollars.

Tomorrow's unit would consist of one central C3 facility maintained in center of the United States much like Cheyenne Mountain. The facility would house personnel equally representing each military service using standard, user-friendly equipment linked to each and every unit, platform, aircraft, ship, submarine, truck, and jeep within the world wherever the troops are deployed. Space-based satellite radar and IFF transmitters and receivers would detect and transmit information to the central C3 facility where it would be analyzed, validated, then retransmitted over secure digitized communications net to the battlefield commanders. The concept would prove costly in terms of research and development and probably prohibitive as a sole military venture. However, the "host" satellite constellations that are required are already on the drawing board and are buying space on the shuttle for deployment.

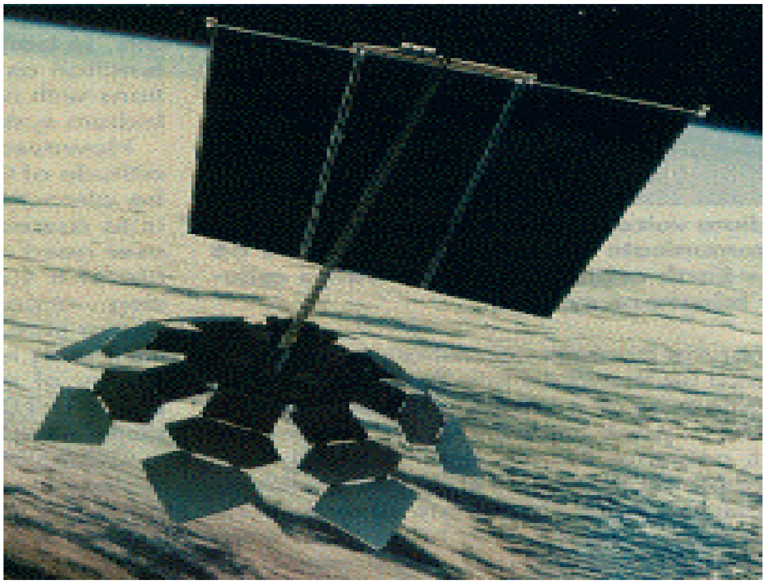
Commercial Support

There are several satellite constellations on the drawing board; however this paper focuses on two that are being developed—the Motorola Corporation's communications system, "Iridium," and the "Teledesic" system being developed by the Teledesic Corporation.

The Iridium is a satellite-based telecommunications system allowing customers to call or be called globally using a special hand-held wireless telephone.[2] The satellite system relays information from 66 orbiting satellites to ground stations scattered throughout the world.[3] The Iridium timetable calls for the first satellites to be launched in clusters every four to six weeks for a year beginning mid-1996 allowing ground-control stations to track their orbit and the system carefully before getting the whole constellation in place.[4] Even before the entire constellation is up, Motorola will make and deploy replacement satellites as earlier ones run out of fuel. The life of a satellite can be as short as one year.[5]

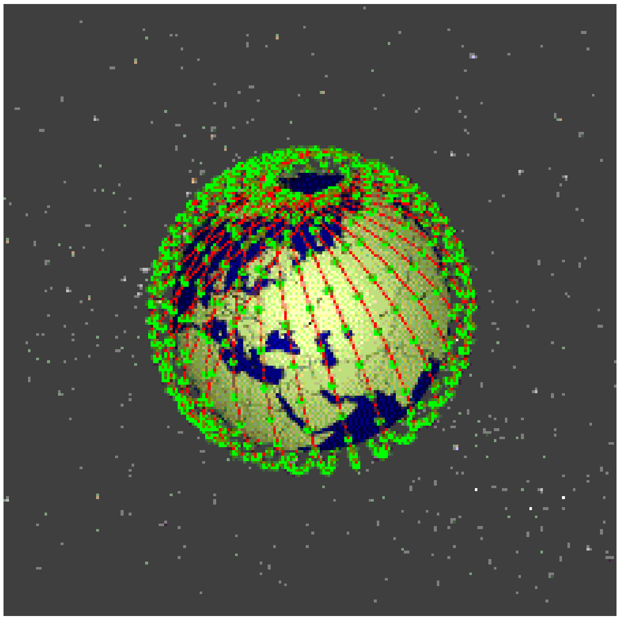
The satellites, which will orbit 483 miles above the Earth, will communicate with Earth terminals scattered around the globe, with its main control facility located in Arizona.[6] The facility will accommodate 10 engineers working 24 hours a day to track the satellites' orbit and position, or telemetry.[7] Once the entire constellation is launched, the main operating facility will be in Virginia and a back-up facility in Italy.[8]

The second system—Teledesic—will provide global communication links via a constellation of 840 (plus 84 spare) low-earth-orbit satellites.[9] The system will act as a network operator to support communications ranging from high-quality voice channels to broadband channels supporting video conferencing, interactive multimedia, and real-time two-way digital data flow.[10] Teledesic will use L-band to send and receive signals from users; each satellite acts as a node in a large-scale packet-switching network (figure 6).[11] Each satellite employs large deployed phased array antenna with a footprint of 700 km which will adequately cover the earth's surface.[12] Figure 7 shows the global coverage of the system while figure 8 depicts a graphic representation of the constellation coverage.



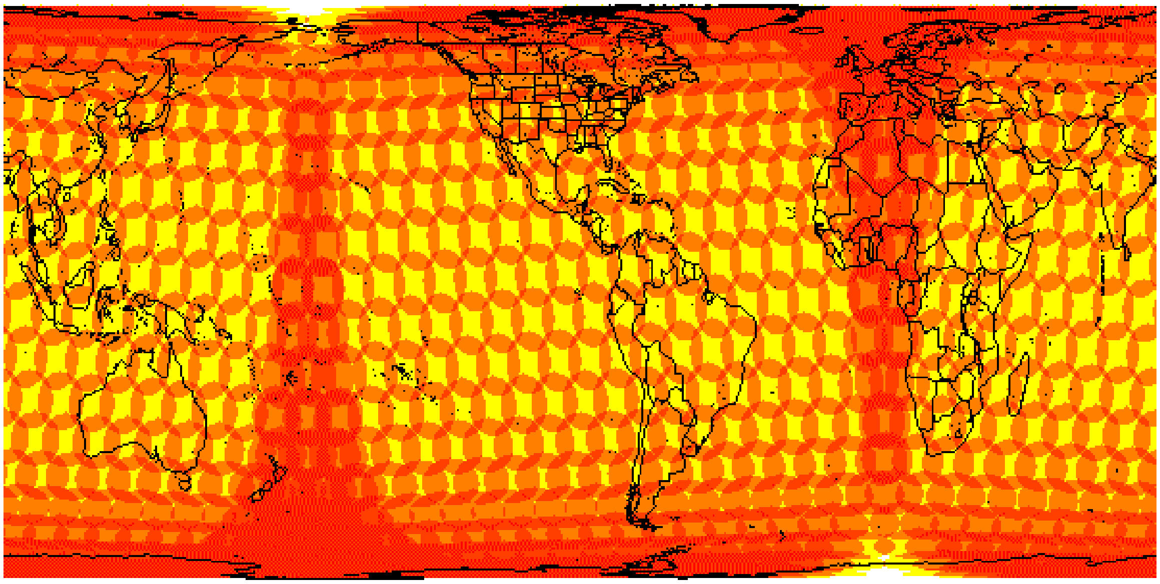
Source: Teledesic Home page (16 December 1996), n.p.

Figure 6. Teledesic satellite.



Source: Mike Evans, New Space Network Home Page, *Mike's Spacecraft Library*, (Jet Propulsion Lab, California Institute of Technology, 7 May 1996),

Figure 7. Teledesic Constellation Location



Source: Mike Evans, New Space Network Home Page, *Mike's Spacecraft Library*, compiled by Steven Johnson, (Jet Propulsion Lab, California Institute of Technology, 7 May 1996), n.p.

Figure 8. Teledesic Satellite Coverage

Launches for this system are planned for 1999-2000, with service to begin in 2001. Each satellite is being designed to not only be compatible with 20+ different launchers, but for multiple launches per vehicle (e.g. 8). Its design life is estimated at 10 years.[13]

Strengths

The strengths of combining military requirements with a planned joint commercial venture of space-based platforms far outweigh the weaknesses. First, and most obvious, is the cost. Each year the military defense budget is sliced and diced for other priority items as deemed appropriate by the administration. The Iridium system is estimated to require a $3.5 billion budget[14] to complete its project. Motorola is seeking funds from national investors as well as ownership stakes to developing countries. The foreign entities will initially be able to invest $275,000,000 which would consist of 275 shares at $1,000 a share.[15] The stakes are expected to replace part of the $300 million that would have been raised from high-yield "junk" bonds in late September. In contrast, the total cost of the Teledesic project is estimated at $9 billion and is backed by Microsoft powerhouse Chairman Bill Gates and Craig McCaw, founder of McCaw Cellular Communications Inc.[16] Funding is being appropriated through a myriad of channels which are economically stabilizing for the economy. Both projects have been designed and scheduled for launch—the systems will be deployed whether the military takes advantage of the platform or not. The sunk cost of money required to acquire a new system has been spent; the defense department need only to design and add the military peculiarities to an existing system. In essence, the systems have been developed; they need to be implemented in space. Redundancy can be considered a strength. Just by the sheer number of satellites within the constellation, there exists a very high probability of maintaining continual service.

Second, the savings in manpower could be realized in a steadily decreasing era of "right-sizing." Today, the defense department employs approximately 6000 military members to support five command and control platforms. Assuming these platforms can be consolidated into one master center and two back-up facilities of (as demonstrated by Motorola), it is feasible to reduce manpower from the present 6000 members to at least a quarter of today's strength. The newly created force would be comprised of the defense department brightest officers and enlisted airmen, sailors, soldiers, and marines to work jointly with the civilian counterparts.

Finally, the most significant reason to eliminate present-day C3 platforms in lieu of space-based is the total absence of loss of life. No longer would these platforms and their crews be subject to adverse weather patterns, deteriorating airframes, or hostile fire or missiles.

Weaknesses

There are three areas of concern. The first concern involves the initial costs and application requirements involved to add the military requirements to a civilian enterprise, the second concern involves maintaining space-based equipment in the event repair is required, and the last concern lies in the old thought process of "all your eggs in one basket."

The initial, or "sunk," costs of developing the radar with the required revisit rates from space could present a budgetary dilemma. Extensive testing would need to be conducted to determine if the radar performs the same in a space environment as it does in an air-breathing environment. If a satellite constellation is kept in a low-earth-orbit, the distance between the satellite and a target should be less than present day radar resulting in better air and surface pictures. In addition, attaching a phased-array radar plus the secure communication and digital data link suites required for the military would probably warrant a satellite redesign. Testing to ensure non-interference with the satellite's original design intent would need to be accomplished as well.

Regarding military application, accessing the satellites during peak traffic is an issue. Will enough frequency bands be available during military times of tension to allow the military user full access to the satellites without impairing the communication requirements of the average Internet user? Will the military need to "commandeer" a subset of the constellation to fulfill military requirements or can technology preclude this action?

Once the satellite constellation is deployed, how will it be maintained? Unless a "break-rate" of zero is determined during testing, resources need to be identified to launch and fix the platform. The US presently does not have the capability to either launch a satellite or put a person in orbit on short notice. However, there is some preliminary work being done on a replacement to shuttle people to space. Another possibility is to "remove and replace" the satellite in toto. Rather than shuttling personnel to space and perform space walks, the good satellite could be deployed and the inoperative satellite retrieved and brought back to earth for repair. The same idea would go for refueling satellites rather than having them drop out of space.

The last area of concern is more of a philosophy blockade and a victim of dogma. Present-day literature is filled with comments, philosophy, and visions suggesting that placing your air-breathing assets strategically around the globe gives a sovereign nation better chance of survivability. It was important to ensure redundancy because technology wasn't available to protect sovereignty globally and yet simultaneously. If technology had stood still for the past 20 years, this philosophy would make sense. Instead, within the past 10 years we have built stealth aircraft, extremely smart weapon systems, and intelligence sensors that were once only realized in science fiction movies. If technology already exists to build space-based laser systems (a good example is the strategic defense initiative constellation), it is not incomprehensible that radar and communication sensors for military application cannot be designed onto developed civilian satellite constellations.

Notes

[1] Teledesic Home Page (16 December 1996), n.p.
[2] Motorola Home Page (16 December 1996), n.p.
[3] Ibid.
[4] Ibid.
[5] Ibid.
[6] Ibid.
[7] Ibid.

Notes

[8] Ibid.

[9] Mike Evans, New Space Network Home Page, *Mike's Spacecraft Library*, compiled by Steven Johnson, (Jet Propulsion Lab, California Institute of Technology, 7 May 1996), n.p.

[10] Ibid.

[11] Ibid.

[12] Ibid.

[13] Teledesic Home page (16 December 1996), n.p.

[14] Motorola Home page (16 December 1996), n.p.

[15] Ibid. Author's note: the mathematics do not match the statement made in this sentence. The sentence is a direct quote from the Motorola home page. Electronic mail traffic and telephone calls to the webmaster at Motorola to confirm these figures proved unsuccessful.

[16] Teledesic Home page (16 December 1996), n.p.

Chapter 4

Where Do We Go From Here?

> *Waiting for a crisis to force us to act globally runs the risk of making us wait too long.*
>
> —Isaac Asimov

Discussion thus far has led to the fact that space-based technology either exists or can evolve to meet the military needs. Commercial satellite systems are nearing deployment—some have already launched their first satellites for a testing phase. The ball now appears to be in the military court: shall we take advantage of civilian enterprise? To take the next step, the military services need to prepare a joint mission need statement, examine space-shuttle use exclusively for repair and/or replacement of satellites, and derive a joint concept of operations to include manpower estimates, as well as training requirements to maintain proficiency once the system is operational.

The joint mission statement is probably the biggest hurdle to tackle in terms of agreement among the services as well as supporting budgetary approval. The statement would focus on using and exploiting known space-based technology to include command and control functions with the ultimate objective of replacing the aging platforms in use today. Continued used of air-breathing platforms will require not only continual repair, but eventual replacement. This cost will be borne solely by the military services since there is no advantage for the civilian sector to participate—both economic facts which cannot be pursued given the lack of future military budget monies. As a joint center, the services will be able to eventually attrit the 100-plus aircraft, 25-plus units, and 6000 personnel presently performing these functions and build a new organization a fraction of the size of today's forces and cost. Each service will need to determine what C3 job specialties are required to provide the battlefield commander information required to make tactical decisions. The civilian counterparts can perform space tracking functions and maintenance on the ground-based and space-based facilities.

A spin-off of the mission need statement and subsequent use of civilians lies in the use of the space shuttle or another technology-driven method of transportation for repairing, replacing, and refueling orbiting satellites. An examination is required to determine whether the Department of Defense should employ a space shuttle fleet of its own, rely on civilian contractors, or a seek a joint venture. Economically speaking, the most cost-efficient method of retaining these services would be a combination of military and civilian flight specialists as well as shuttle services. The present thought process is to allow the constellations to run out of fuel and fall from orbit—and there are no unclassified plans for in-space repair. Both disadvantages can be countered by an effective shuttle program to either repair or replace the defective satellites. According to the February 17, 1997 issue of the *Air Force Times*, the "space plane" could be the answer to this problem. The proposed vehicle would be "capable of flying to any point on Earth or to low-earth-orbit and back in less than one hour" as well as "capabilities to include six-to-eight hour turnaround after landing, all-weather operations and ability to respond to conflict anywhere on the globe from bases in the continental US within 40 to 60 minutes." The article also stated that "if approved…the reusable plane would begin flying in 2010."

Finally, the tangible aspect of this concept is defining and refining the concept of operations—this will require people with forward vision, not plagued with dogmatic values and ideas. Who will write the doctrine required to formulate the joint space-based concept of operations? One of the many areas to be refined is manpower estimates. How many people will it take to staff the master and back-up control centers, the repair services, the shuttle services, and what services will contribute the job specialties required? What will be the balance between military versus civilian population? Once this thought process is complete, the next concept to embrace is the training of personnel involved. Either retrofitting existing or creating new training facilities will enable training for not only the mission specialists in the control facilities, but also flight operations and space repair/refueling. Training will require simulators for both the mission specialists as well as all aspects of flight operations in space. The large corporations with planned satellite constellations already have programs in motion—the military would not need to reinvent the wheel. Finally, once personnel are equipped and trained, a program to ensure proficiency in all matters relating to defense and maintenance is needed. This proficiency can come in the form of daily practice either in the center itself or simulators as well as planned joint exercises.

Chapter 5

Conclusions

> *We are at the turning of the ways in the development of our air power and the people, who are the judges of what should be done, should weigh the evidence on the subject carefully.*
>
> —Billy Mitchell regarding national air power, 1925

General Billy Mitchell wrote the words quoted above in 1925. Seventy-two years later, we are once again at the same juncture, but can replace the words "air power" with "air and space power." To maintain the edge of command and control, we must be able to gain the most amount of information, in the fastest, cheapest, and safest way possible, then provide that information to the battlefield commander anywhere on the globe. Several civilian enterprises are ready for satellite constellation launches, and with some redesign efforts, could possibly provide the hardware required to fulfill military command and control needs—it would be economically foolish not to take advantage of this technology. In particular, the Teledesic 840-strong satellite constellation is programmed for a low-earth-orbit and with design focusing on no "blind" spots. Given this orbit altitude, the satellite could be optimally redesigned to include phased array radar's to detect and transmit intelligence data to the earth's surface. If a constellation were designed to not only transmit and receive the data for its intended use (cell phones, Internet activity, etc.), but also military satellite communication and radar requirements, it could perform the same tasks the E-2C Hawkeye, E-3 AWACS, E-8 JSTARS, EC-130E ABCCC, and MCE facility do today at a fraction of the present annual operating costs. While the costs savings are significant, the most critical benefit realized will be no loss of life. If all critical battlefield information can be derived and transmitted electronically by satellite, there will be no need for high valued assets to orbit in hostile territories anticipating the next missile launch against them.

Glossary

List of Acronyms

ABCCC	Airborne Battlefield Command and Control Center
AFB	Air Force Base
AWACS	Airborne Warning and Control System
BDA	Battle Damage Assessment
C3	Command and Control
C^4I^2SR	Command, Control, Communications, Computers, Intelligence, Interoperability, Surveillance, and Reconnaissance
DGSS	Deployable Ground Support System
GSM	Ground Service Module
HF	High Frequency
IJMS	Intermediate Joint Messaging System
JSTARS	Joint Surveillance Targeting and Radar System
JTIDS	Joint Tactical Identification System
MCE	Modular Control Element
NATO	North Atlantic Treaty Organization
SATCOM	Satellite Communications
SCDL	Surveillance Control Data Link
TADIL-A	Tactical Digital Link - Alpha
TADIL-J	Tactical Digital Link - JTIDS
UHF	Ultra-High Frequency
UN	United Nations
USA	United States Army
USAF	United States Air Force
USN	United States Navy

VHF Very High Frequency

Definitions:

DGSS. SATCOM based data link to GSMs. Carries JSTARS surveillance picture plus free text messages to units outside of SCDL line-of-sight.

IJMS. Method of communicating electronic data between two IJMS compatible units using UHF radio. Works on a series of allocated times slots polled at different intervals. Normal typewritten messages available on this link.

JTIDS. An advanced information distribution system that provides secure integrated communication, navigation, and identification capability for application to military tactical operation.

Link-11/TADIL-A. Communication link suitable for transmission of digital information. a TADIL is characterized by its standardized message formats and transmission characteristics. Referred by USAF as TADIL-A and by USN as Link-11.

Link-16/TADIL-J. Method of communicating electronic data between two Link-16 compatible units using UHF or HF radio. Equipment used to translate data is the KG-80v. Referred by USAF as TADIL-J or Link-16 and by USN as Link-16. New in inventory; several fighter aircraft equipped as well as one carrier fleet.

radome/rotodome. Six-foot radar dish located near the tail section of the E-3 AWACS

SCDL. Primary UHF data link between JSTARS and its GSM.

stovepiping. Resources developed and acquired to fulfill one purpose within one service; technology laterally limited to other services.

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